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GE Aircraft Engines

Sarah M. Knife
GE Aircraft Engines
One Neumann Way, Cincinnati, OH 45215-1988

Mail Drop: J60
Dial Comm: 8-332-3032
Phone: 513-243-3032
E-Mail: sarah.knife@ae.ge.com

October 19, 1999

Subject: 25.903e Response

To: GP Sallee/Boeing Commercial Airplane Group
JC Tchavdorov/Airbus Industrie
Mike McRae/Federal Aviation Administration
Robin Boning/Civil Aviation Authority

Ref.: 25.903e Response

It has become apparent that there is considerable technical disagreement over the contents of draft rule and AC 25.903e. (Ref. 1, 2, 3) In view of this widespread technical disagreement and the magnitude of the proposed departure from current industry practice, GE supports Pratt & Whitney's request that the draft rule and AC not be presented to TAEIG, and that this rule should be removed from the fast-track process and tasked as a full rule-making project.

In the interim, GE proposes that the Generic Special Condition (Ref. 4) continue to form the basis for demonstration of compliance with the intent of 25.903e.

References:

1 GE Minority Position on Proposed AC 25.903(e), September 17, 1999, S Knife to GP Sallee and JC Tchavdorov
2 P&W Comments on Proposed 25.903(e), September 21, 1999, M Romanowski to GP Sallee and JC Tchavdorov
3 Cessna Minority Position on Draft AC/ACJ 25.903(e), August 19, 1999, B Miles and R Barnes to GP Sallee and JC Tchavdorov
4 Generic Special Condition

Original signed by Bev Kersh for

Dr. Sarah M. Knife
Senior Staff Engineer - Industry & Regulatory Affairs
Flight Safety Office, GE Aircraft Engines

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GE Aircraft Engines
One Neumann Way, Cincinnati, OH 45215-1988

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Phone: 513-243-3032
E-Mail: sarah.knife@ae.ge.com

Subject: Minority Position on Proposed AC 25.903 e)

Date: September 17, 1999

To: GP Sallee Co-chair, PPIHWG
JC Tchavdorov Co-chair, PPIHWG

This minority position documents areas of substantive disagreement which were raised within the working group, and which were not dispositioned at the time.

A. ALTERNATE MEANS OF COMPLIANCE

This advisory material is introduced "to maintain the current level of safety" (section 4.3) with respect to recovery from an all-engine power loss event. Improving the level of safety may be achieved by reducing the likelihood of the all-engine power loss taking place, or by improving the likelihood of aircraft recovery in the event of an all-engine power loss. It can be seen from Chart 1 that the incidence of all-engine power loss is apparently decreasing. It can also be seen that the incidence of such events in high bypass ratio propulsion systems is trending downward and is now very low compared to the overall fleet history. The improvement noted in Chart 1 may be attributed to the considerable efforts made by the regulatory authorities and industry over the last 10 years, to control the incidence of all-engine power losses, by changes to the engine and aircraft requirements and design to render the engine more robust to inclement weather and FOD. It would therefore appear from service experience that reducing the likelihood of the initial all-engine out event is an effective way to maintain overall aircraft safety.

It should be noted that some of these changes have rendered windmill start more difficult, so that it may take longer or only be possible in a smaller flight envelope. However, none of the all-engine power loss events have been unrecoverable due to a small windmill start envelope, or to slow spool-up times from windmill start.

It is suggested that the intent of the rule would be better met if at least partial compliance could be demonstrated by design provisions minimizing the likelihood of the initial all-engine power loss. It is therefore proposed that wording be added as follows:

7 - COMPLIANCE GUIDANCE

This section is intended to define overall restart performance that includes the use of power assisted and windmill restart capabilities and to describe acceptable compliance guidelines.

The effects of the loss of engine power from one, multiple and all engines must be considered. However, the loss of all engines generally determines the most stringent requirements in terms of restart capability, and the intent of the regulation will be satisfied by addressing this critical case.

In order to confirm that engine restarting can be achieved, in circumstances where all engines run down or are shut down, the applicant will be expected to show by test or analysis supported by tests that sufficient power/thrust can be restored to enable the airplane to achieve level flight without excessive loss of altitude. **For propulsion systems where design provisions have been made to address the majority of known causes of all-engine power losses at a given flight condition, the risk of an unrecoverable all-engine power loss will be considered to be greatly reduced, and therefore there is no need to demonstrate compliance with the altitude loss requirement for that flight condition .**

Four conditions are to be addressed :

1. Shut down from take off/climb power with pilot recognition time delay based on analysis of indications (inherent or dedicated indicators) to the flight crews. (Pilot recognition time has typically ranged from 5 to 15 seconds based on service data.) **Service events at this flight condition have resulted primarily from crew inadvertently shutting down all engines .**

Acceptable means of compliance include rapid relight procedures or starter assistance from an external power source. The altitude loss between initiating the restart and achieving level flight should not exceed 2500 ft.

2. An engine should be able to be restarted at a minimum altitude of 15,000 ft from a shut down at typical descent speed at 20,000 ft or above. **Service events at this flight condition have resulted primarily from engine icing and fuel system malfunction.**

3. The engine should be able to be restarted with an altitude loss not exceeding 5000 ft from a power loss occurring between 10,000 and 20,000 feet. **Service events at this flight condition have resulted primarily from inclement weather and engine icing, and have only occurred for descent power.**

The aircraft speed at the time of power loss should be representative of the normal flight profile (climb or descent) in this altitude range for the flight phase considered.

4. Flame out or shut down from descent power below 10,000 ft with a delay in crew action based on indications (inherent or dedicated indicators) to the flight crew of all engine power loss. **Service events at this flight condition have resulted primarily from inclement weather (rain/hail ingestion).**

A 30 second crew recognition time should be used if no dedicated indication is provided. Crew Recognition Time may be shortened based upon dedicated indications that engines have flamed out or rolled back to sub-idle, as well as aircraft design features which minimize the potential for inadvertent shutoff. Other factors which may be considered in the crew recognition time evaluation include automatic relight and automatic sub-idle stall recovery systems.

The initial airplane speed that should be used for the all-engine out restart evaluation is 1.45 Vstall (clean configuration) of the maximum landing weight of the aircraft. Acceptable means of compliance include rapid relight, starter assistance from an external source and stabilized windmill start. The airplane should not lose more than 5000 feet altitude between initiating restart procedures and achieving level flight. In addition, the maximum aircraft speed to achieve the restart should not exceed 250 kts.

B. BASIS FOR AC IN SERVICE EXPERIENCE

Section 4.2 states "The service experience supports the position that suitable engine restart capability must be available following the loss of all engine power to avoid an unsafe condition." A database of all events of complete engine power loss occurring in the commercial transport fleet[1] was compiled by the working group. Although detailed information on airspeeds and altitudes was not available for every event, the flight phase was available for 41 of the 50 events, giving a general indication of the flight condition. (Chart 2 shows the events by flight phase, with more detailed information added where it was available.) The data collected gives a statistically valid sample of all-engine power loss events, and can therefore be used as the basis for the conditions to be flown.

The flight conditions specified in the AC do not reflect the flight conditions at which the majority of all-engine power losses have historically occurred, according to this database. Specifically, condition 4 (low power, below 10,000 ft, 1.45 Vstall) reflects a more severe condition than has been documented for an all-engine power loss in the commercial transport fleet. It is proposed that the requirement of section 7, condition 4, for an initial airspeed of 1.45 Vstall be changed to permit a higher initial airspeed such as 250 kts.

C. CAPABILITY OF EXISTING FLEET

Since this advisory material is introduced "to maintain the current level of safety" (section 4.3), the conditions to be demonstrated should be within the capability of the majority (50%) of the existing fleet. It is not possible to establish from existing data whether the majority of the existing fleet could meet section 7, condition 1 (high power fuel cut and recovery within 2500 ft), but the limited information available suggests that most of the fleet could not demonstrate this condition. The alternate means of compliance proposed above (A) may provide some relief. It is proposed that the wording of section 7, condition 1 be changed as follows:

> Acceptable means of compliance include rapid relight procedures or starter assistance from an external power source. ~~The altitude loss between initiating the restart and achieving level flight should not exceed 2500 ft~~.

Chart 3 shows the minimum windmill start airspeed as a function of aircraft certification date. Half of the engine/airframe combinations currently in service are capable of windmill start, S/L, at 250 knots. Therefore a reasonable criterion for maintaining the current safety standard would be 250 knots rather than 1.45 Vstall. The following wording change is proposed to Section 7, condition 4:

> The initial airplane speed that should be used for the all-engine out restart evaluation is **250 kts**. Acceptable means of compliance include rapid relight, starter assistance from an external source and stabilized windmill start. The airplane should not lose more than 5000 feet altitude between initiating restart procedures and achieving level flight.

Sarah M. Knife Ph.D.

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[1] Excluding military action and events where at least one engine was always running, although all engines were sequentially shut down in the flight, and excluding events where engine damage during the power loss prevented restart.

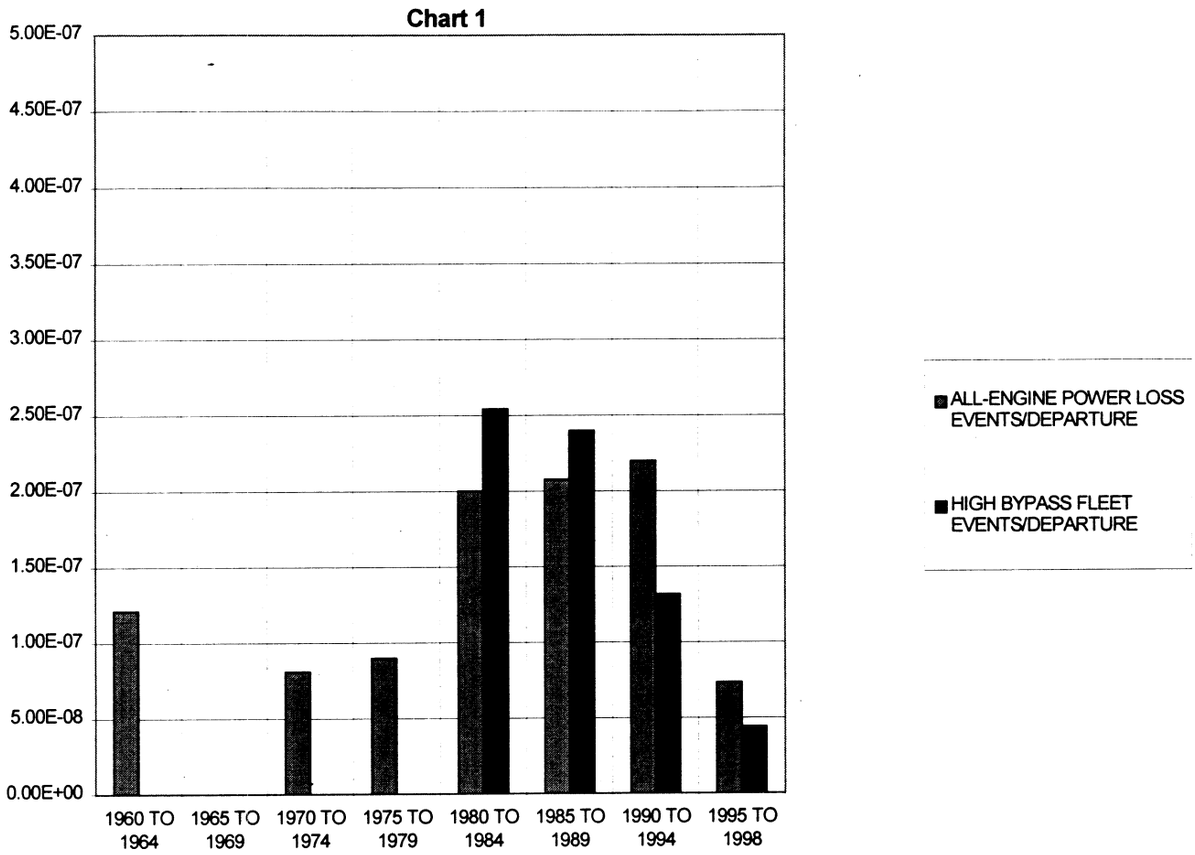
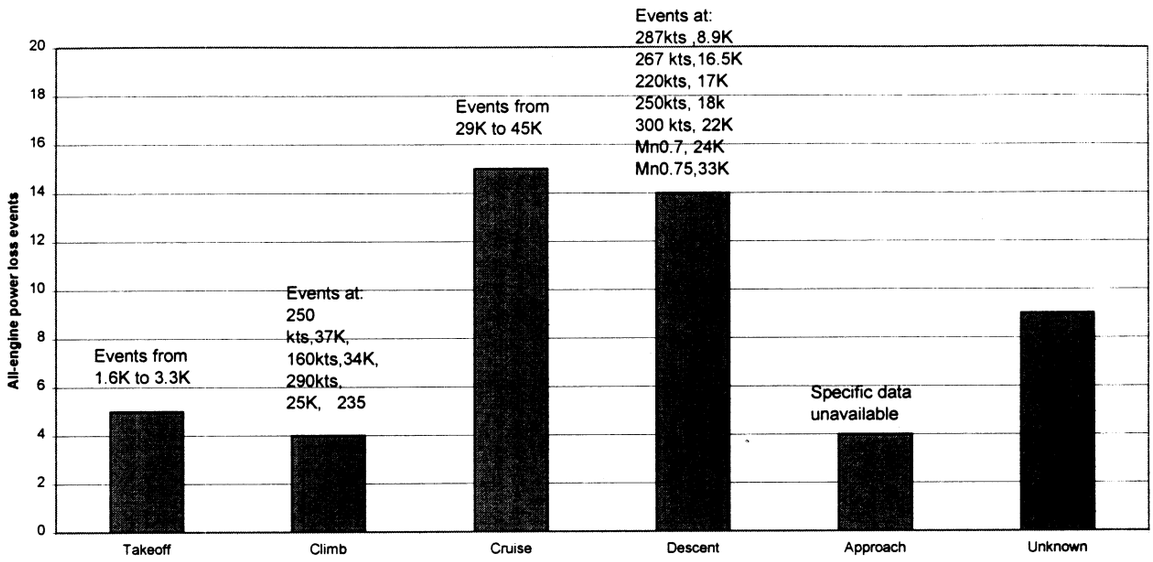


Chart 1
5.00E-07
4.50E-07
4.00E-07
3.50E-07
3.00E-07
2.50E-07
2.00E-07
1.50E-07
1.00E-07
5.00E-08
0.00E+00
1960 TO 1964
1965 TO 1969
1970 TO 1974
1975 TO 1979
1980 TO 1984
1985 TO 1989
1990 TO 1994
1995 TO 1998
ALL-ENGINE POWER LOSS EVENTS/DEPARTURE
HIGH BYPASS FLEET EVENTS/DEPARTURE

CHART 2
Commercial Transport Fleet All-Engine Power Loss Events, by Flight Phase
1960-1996



Majority of events occur at high/intermediate altitudes. Low altitude/low airspeed/low power scenario (condition 4) represents no events/ a very small proportion of events

Chart 3
Certified Windmill Start Envelopes